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The Dynamics of the Parasitic Fauna of Different Forms of the Arctic Char Salvelinus alpinus L. in the Basin of Lake Azabach'e

by T.E. Butorina, Marine Biology Institute, Vladivostok

We investigated the parasitic fauna of different intraspecific forms of Arctic char in Lake Azabach'e (Kamchatka) from the age standpoint. Fingerlings and yearlings up to 10 cm long have a similar parasitic fauna in different forms of Arctic char. In their second year of life, the fish vary their food habits: predaceous Arctic char feed on fish, and benthophages on amphipods and mollusks, while brook and diadromous char feed mainly on larvae and adult insects. These changes are reflected in the fishes' parasitic fauna, which differs considerably in the above forms. We distinguished two groups of parasites infestation ~~with~~ which intensified and declined with the age of their Arctic char hosts. We studied the details of the biology of some char parasites. We noted that helminths developed later than in the northwest European USSR.

/237*

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The study of the dynamics of parasitic fauna is an important area of ecological parasitology (Dogel', 1958). Research on the dynamics of parasitic fauna enables scientists on the one hand to study the biology and the life cycles of parasites, and on the other to trace changes in the ecology of the host fish themselves against a background of changing environmental conditions. Many authors (Malakhova, 1963; S. Shul'man and Rybak 1964; Kashkovskii, 1965; Rumyantsev, 1966) have pursued such investigations. The study of the age changes in parasitic fauna calls for thorough analysis of this fauna's dependence on the morphological and ecological changes characterizing the successive stages of fish development (Polyanskii and R. Shul'man, 1969). V.A. Dogel' (1948) formulated the overall patterns in the age dynamics of parasitic fauna; this work was later supplemented by Yu. I. Polyanskii and S.S. Shul'man (1956). Subsequent studies confirmed the correctness of the main conclusions describing the patterns of age changes in parasitic fauna (Kulemina, 1969; Chernysheva, 1969; Yunchis, 1971, and others).

We previously established the differences in the parasitic fauna of various intraspecific forms of Arctic chars (lake predators and benthophages, and brook and diadromous forms) inhabiting Lake Azabach'e and the Kamchatka River and described each form briefly (Makhovenko, 1972). Our objective in this study was to determine the changes in the parasitic fauna of different Arctic char forms depending on their food habits. For this purpose we undertook to study the incidence of infestation of chars of different age groups from Lake Azabach'e and the Kamchatka River.

Material and Methods

We collected our material in the basin of Lake Azabach'e (Kamchatka) from 1969 to 1971 and in 1973. When we studied the age changes in the parasitic fauna we dissected the fish parasitologically, beginning with the fingerlings and examining 15 or 16 specimens in each age group. We did not succeed in investigating the parasitic fauna of larvae [fry] since we did not know the spawning grounds of the char in Lake Azabach'e. In order to study the age dynamics of the parasitic /238
fauna of the different char forms, we divided them into four size groups corresponding to a definite age. We determined the age of the fish from their scales (Table 1).

Table 1

Number of Juvenile Char of Different Size Groups Investigated

Таблица 1

Количество исследованной молоди гольцов разных размерных групп

Length Длина см cm	Age of Возраст рыб fish	Lake Azabach'e оз. Азабачье			Azabach'ya River р. Азабачья		Kamchatka River р. Камчатка
		хищники predators	бентофаги benthophages	ручьевые brook	хищники predators	бентофаги benthoph.	проходные brook
6—10	0+—1+	1	5	15	4	2	6
11—15	1+	15	16		15	15	6
16—20	2—2+	15	16	15			2
21—30	2+—3+	16	15		15	—	15

In addition, we observed the life cycles and the developmental and maturation periods of certain char parasites. We did our research in the summer and autumn. Every month we dissected 15 to 17 fish of each char form that we studied. We examined a total of 494 fish by the method of a full parasitological dissection; this total broke down as follows:

predators in Lake Azabach'e	93
benthophages, Lake Azabach'e	93
predators in the Azabach'e River	76
benthophages [in the Azabach'e River]	47
brook char	90
diadromous [forms]	75
juveniles of all forms up to 10 cm long	20

The latter do not appear in Tables 2, 3 or 4 owing to insufficient material, but we allowed for the results of their examination in discussing the age dynamics of parasitic fauna.

We caught brook char in the lake and the upper reaches of small rivers flowing into Lake Azabach'e, and diadromous [forms] in Kamchatka Gulf, the Kamchatka River, the Azabach'ya River and Lake Azabach'e.

Age Changes in the Parasitic Fauna of Different Char Forms

The parasitic fauna of predaceous char. Fingerlings and yearlings 6 to 10 cm long live in the shallows of small rivers and Lake [Azabach'e itself]. In the juvenile predators of this age group we found the protozoans Trichodina nigra kamchatika G. Stein, 1966; Trichophyra piscium Butschli, 1889; Apiosoma sp; Chloromyxum coregoni

Bauer, 1948; Myxidium salvelini Konovalow et Schulman, 1966; Myxobolus neurobius (Schuberg et Schröder, 1905); the cestode Proteocephalus exiguus (La Rue, 1911); and the nematode Cucullanus truttae (Fabricius, 1794). Infestation with P. exiguus indicated that the juveniles fed on plankton; in the small rivers the juveniles were infested with C. truttae.

In their second year of life (length 11-15 cm) the juveniles' food habits changed considerably. The predators began to feed on juvenile sockeye salmon, coho, smelt and stickleback, which was reflected in their parasitic fauna (Table 2). The cestodes Diphyllobothrium sp., and Eubothrium salvelini (Schrank, 1790) appeared among them. The predators sometimes ingested bottom animals as well, which we saw from a study of their stomach contents. Infestation with such parasites as Cyathocephalus truncatus (Pallas, 1781), Cystidicola farionis Fischer, 1798, and Metechinorhynchus salmonis (Müller, 1780) can originate both through intermediate hosts and from feeding on infested fish.

Among lake predators that had reached two years of age (length 16-20 cm) the percentage of infestation with cestodes of Diphyllobothrium sp. rose to 40, and the corresponding figure for E. salvelini, to 80, with a simultaneous increase in the incidence of infestation. At the same time, their infestation with P. exiguus and C. truttae diminished (Table 2).

In the predators' third to fourth year of life (length 21-30 cm) their incidence of infestation with cestodes of Diphyllobothrium sp. /239 reached 50%, and with E. salvelini, 100%, while the density of infestation increased simultaneously. We saw an increased invasion of the char by the protozoans T. piscium and M. neurobius, trematodes, and

the nematode Cystidicola farionis (Table 2). Two- to three-year-old chars became typical predators in their food habits. The considerable increase in their infestation with Diphyllobothrium sp., E. salvelini and C. farionis was due to the consumption of a larger number of fish and the accumulation of parasites as a result of reinvasion.

Table 2

Age Changes in Parasitic Fauna of Predaceous Char of Lake Azabach'e (15 to 16 specimens of each [char form] dissected)

Таблица 2

Возрастные изменения паразитофауны гольцов-хищников оз. Азабачьего (вскрыто по 15—16 экз.)

Паразит Parasite	оз. Азабачье Lake Azabach'e						р. Азабачья Azabach'ya river			
	11—15 см		16—20 см		21—30 см		11—20 см		21—30 см	
	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.
	degree of infestation									
Dermocystidium salmonis	0		0		6.7		0		0	
Myxidium salvelini	6.7		6.7		25.2		0		6.7	
Zschokkella orientalis . . .	0		0		0		0		6.7	
Myxobolus neurobius . . .	6.7		6.7		44.1		33.5		33.5	
Trichodina nigra kamchatika	0		0		6.7		0		0	
Trichophrya piscium	6.7		40.2		50.4		6.7		6.7	
Aplosoma sp.	6.7		0		0		0		0	
Tetraonchus alascensis . . .	0		6.7	1	0		0		0	
Eubothrium salvelini . . .	46.9	9	80.4	10	100	19.7	73.7	6.7	93.8	15.8
Cyathocephalus truncatus	13.4	2.5	20.1	1.2	12.5	3.5	6.7	1	0	
Diphyllobothrium sp. larva	20.1	2.3	40.2	4.2	50.4	4.5	6.7	1	33.5	6.2
Proteocephalus exiguus . .	46.9	1.4	6.7	8	18.8	3	33.5	1.3	6.7	1
Phyllodistomum conostomum	6.7	2	20.1	3.3	12.5	12	33.5	1.2	26.8	3.5
Crepidostomum farionis . .	26.8	1	26.8	6	44.1	10.4	33.5	5.5	40.2	5.2
Diplostomum sp.	0		20.1	1.3	50.4	12.8	33.5	4.5	26.8	4.7
Contracaecum sp.	33.5	1.3	13.4	47.5	0		26.8	1.5	20.1	22
Cystidicola farionis	13.4	4	67	25.9	88.2	16.5	33.5	10	26.8	9.3
Cucullanus truttae	73.7	2.6	60.3	3.5	69.3	4.8	60.3	6.1	46.9	2.3
Philonema oncorhynchi . .	6.7	1	0		12.5	1.5	6.7	7	20.1	5.8
Neoechinorhynchus rutili	13.4	1.5	20.1	4	6.3	8	46.9	17.8	33.5	9
Metechinorhynchus salmonis	33.5	2.3	40.2	2.9	31.5	2	20.1	1	53.6	4.3
Anolonta yukonensis глохидии—glochidia . .	0	—	6.7	3	12.5	1	0	—	20.1	3.3
Salmincola edwardsii . . .	6.7	1	0	—	0	—	0	—	0	—

The parasitic fauna of benthophages. Juvenile benthophages 6 to 10 cm long in their ecology and food habits resemble juvenile predators of the same size. The parasitic fauna of the benthophages of this age group does not differ from that of the predators.

At the age of 1+ and a body length of 11 to 15 cm the juveniles change over to feeding on benthos: mollusks and amphipods. At the same time, important changes take place in their parasitic fauna (Table 3). Infestation with C. truncatus, Cystidicola farionis and M. salmonis is due to the consumption of their first intermediate hosts - amphipods - while infestation with Phyllodistomum conostomum (Olsson, 1876) originates from eating mollusks.

Juvenile benthophages were far more heavily infested than predators of the same size with M. neurobius, whose spores they ingested from the bottom of a water body. The degree of infestation of benthophages with C. truttae, like that of predators of the same age group, was fairly high (Table 3).

The parasitic fauna of two-year-olds (length 16-20 cm) was characterized by an increase in infestation with trematodes, the nematode Cystidicola farionis and glochidia of [the freshwater mussel] Anodonta (Table 3).

Among benthophages in their third to fourth year of life (length 21-30 cm) we observed an increase in the incidence of infestation with certain protozoans, and invasion by trematodes and thorny-headed worms [acanthocephalans] intensified. At the same time, the infestation of Arctic char with C. truttae declined (Table 3).

Table 3 /240

Age Changes in the Parasitic Fauna of Benthophages of Lake Azabach'e (15 to 16 specimens of each [fish] dissected)

Таблица 3

Возрастные изменения паразитофауны бентофагов оз. Азабачьего (вскрыто по 15—16 экз.)

Паразит / Parasite	оз. Азабачье Lake Azabach'e						р. Азабачья Azabach'ya River			
	11—15 см		16—20 см		21—30 см		11—20 см		больше 40 см over	
	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.
	degree of infestation									
Dermocystidium salmonis	0		6.3		20.1		0		0	
Myxidium salvelini	0		6.3		6.7		6.7		6.7	
Zschokkella orientalis . . .	0		6.3		0		0		0	
Chloromyxum coregoni . .	6.3		0		6.7		0		0	
Myxobolus neurobius . . .	37.8		31.5		67		26.8		53.6	
Myxobolus krokhini	0		0		6.7		0		0	
Trichophrya piscium	0		25.2		53.6		6.7		0	
Tetraonchus alascensis . . .	0		6.3	1	6.7	1	0		0	
Cyathocephalus truncatus	69.3	8	18.8	19	40.2	15.7	13.4	6.5	53.6	6.2
Proteocephalus exiguus . .	12.5	4	13.4	2	13.4	5	20.1	2.3	0	
Phyllodistomum conostomum	12.5	10.5	18.8	29.7	46.9	14.6	40.2	51.7	80.4	50
Crepidostomum farionis . .	18.8	1.3	44.1	8.8	46.9	28.3	26.8	8.5	20.1	8.7
Diplostomum sp.	6.3	3	18.8	9.3	40.2	10	46.9	4.6	46.9	5
Contracaecum sp.	6.3	1	6.3	16	33.5	7	6.7	3	6.7	3
Cystidicola farionis	25.2	30.3	37.8	13.5	67	46.9	13.4	1	26.8	40.3
Cucullanus truttae	88.2	3.9	69.3	4.9	53.6	4	67	4.7	0	
Philonema oncorhynchi . .	0		0		6.7	1	0		0	
Neoechinorhynchus rutili	12.5	4	0		13.4	1.5	6.7	25	0	
Metechinorhynchus salmonis	50.4	5.9	31.5	16	53.6	109	20.1	52.7	67	90.5
Anodonta yukonensis глохидии—glochidia. . .	6.3	1	12.5	2.5	26.8	6.5	0		20.1	41.7
Salmincola edwardsii . . .	0		0		13.4	2	0		13.4	1.5

The parasitic fauna of brook char. The ecology and food habits of brook char vary little during their life. Their parasitic fauna does not undergo the significant changes that are observed among other char forms.

Among juveniles 6 to 10 cm long we found protozoans, the cestode P. exiguus, and the nematode C. truttae. When their bodies were 11 to 15 cm long we observed an increase in infestation by these parasites and found solitary specimens of Philonema oncorhynchi Kuitunen-Ekbaum, 1933 and Cystidicola farionis.

Brook char 16 to 20 cm long have reached sexual maturity, and at this point we are dealing with adult fishes, among which we observe an increase in infestation with different parasites and primarily C. truttae, due to the migrations of char into the lake, where infestation takes place. The chars' food becomes more diverse, as reflected in the species composition of their parasites. On the whole, the parasitic fauna of brook chars is heavily depleted by comparison with that of other forms (Makhovenko, 1972). This is especially noticeable when we study the brook chars inhabiting the upper reaches of small rivers and brooks. Thus in the Lotnaya River we found among them only C. truttae, and in the Ponomarka River P. exiguus and M. neurobius in addition to this parasite.

The parasitic fauna of diadromous chars. Diadromous chars spend two to four years in fresh water and then migrate to the sea. Juvenile diadromous chars 6 to 10 cm long are infested with protozoans, C. truttae, P. exiguus, and isolated Crepidostomum farionis (Müller, 1874).

In their second year of life (length 11 to 15 cm) the feeding of diadromous chars becomes more diverse and includes insects and larvae, benthos and occasionally fish. Hence among them we now see different parasites that are typical of both benthophages and predators, but in small numbers. The parasitic fauna of two-year-olds (length 16-20 cm) does not vary significantly.

We studied the parasitic fauna of diadromous chars 21 to 30 cm long after the fish returned from the sea. This fauna differed sharply from that of younger chars in the appearance of marine parasites (Table 4). /241

We distinguished two groups of diadromous chars returning from the sea to fresh waters: small (20-30 cm) and large (30-70 cm). The latter were going for spawning. We are still uncertain as to why small diadromous chars migrate. V.V. Volobuev observed a similar phenomenon on the Okhotsk coast (1973).

Table 4

The Parasitic Fauna of Diadromous Chars (15 specimens of each [fish form] dissected)

Таблица 4

Паразитофауна проходных гольцов (вскрыто по 15 экз.)

Паразит / Parasite	оз. Азабачье Lake Azabach'e		Kamchatka R. Камчатка				Камчатский залив Kamchatka Gulf	
	21—30 см		30—70 см		21—40 см		40—60 см		30—80 см	
	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.
	degree of infestation									
Dermocystidium salmonis	6.7		13.4		13.4		13.4		0	
Myxidium salvelini	6.7		13.4		6.7		0		0	
Zschokkella orientalis	13.4		6.7		6.7		20.1		0	
Myzobolus neurobius	33.5		80.4		80.4		46.9		40.2	
Eubothrium salvelini	6.7	1	33.5	26.8	60.3	10.4	33.5	1.6	13.4	3
Diphyllobothrium sp. larvae	0		33.5	13.4	20.1	2	0		0	
Proteocephalus exiguus	6.7	1	20.1	2	0		0		0	
Pelichnibothrium speciosum	40.2	1.5	13.4	1	73.7	7.1	80.4	39	67	19.6
Phyllodistomum conostomum	0		46.9	22.3	40.2	26.5	0		0	
Crepidostomum farionis	46.9	23.1	67	26.7	40.2	14.4	0		0	
Diplostomum sp.	6.7	3	13.4	1.5	53.6	5.3	6.7	1	0	
Lecithaster gibbosus	6.7	2	0		20.1	4	73.7	124	46.9	1.4
Contracaecum sp.	6.7	1	13.4	1.5	13.4	1.5	26.8	2	0	
Cystidicola farionis	13.4	154.5	87.1	32.6	33.5	35.2	0		0	
Cucullanus truttae	67	3.1	46.9	15.3	33.5	5	20.1	1.3	53.6	3.5
Philonema oncorhynchi	0		26.8	2	13.4	1.5	6.7	1	0	
Anisakis sp. larvae	13.4	1	80.4	1.7	20.1	1	26.8	1.3	6.7	1
Neoechinorhynchus rutili	0		6.7	4	13.4	1.5	0		0	
Echinorhynchus gadi	67	2.4	13.4	4.5	60.3	10.7	46.9	39.7	80.4	6.9
Metechinorhynchus salmonis	0		53.6	19.5	6.7	1	0		0	
Bolbosoma caenoforme	46.9	1.6	0		60.3	2.8	53.6	8	40.2	2
Anodonta yukonensis глохидии—glochidia	0		13.4	18	6.7	1			0	
Salmincola edwardsii	0		13.4	2.5	0		6.7	4	6.7	1

We compared the parasitic fauna of the above two groups of diadromous chars (Table 4). The species composition of the parasites of both groups of chars proved to be similar, and we observed differences only in the extensiveness and density of the infestation. Elements of marine parasitic fauna were characteristic of both groups of migrating chars. As the char advanced up the Kamchatka River, they lost their marine parasites and acquired freshwater parasites (Table 5). Chars that had just come in from the sea were heavily infested with the marine parasites Pelichnibothrium speciosum (Monticelli, 1889), Lecithaster gibbosus (Rudolphi, 1802) and Echinorhynchus gadi (Müller, 1776). Of the freshwater parasites they kept [those attacking] cavities (M. salvelini), extracellular parasites (M. neurobius) and euryhaline parasites (C. truttae). At the same time, the char were infested with E. salvelini and Salmincola edwardsii (Olsson, 1869).

Among the diadromous chars that reached Lake Azabach'e we found the following marine parasites: P. speciosum, L. gibbosus, Anisakis sp., E. gadi and Bolbosoma caenoforme Heitz, 1920. The larvae of Anisakis sp. and the acanthocephalans stayed the longest on the fish in fresh water; the former parasitized the body cavity, and the latter penetrated deep into the wall of the intestine with their hooked proboscis, causing severe ulcerations.

The Biology of Some Char Parasites /243

In this section we shall give data on the life cycles and developmental and maturation periods of some char parasites.

The Dynamics of the Parasitic Fauna of Lake Azabach'e chars (15 to 17 specimens of each [form] dissected)

Таблица 5

Динамика паразитофауны гольцов оз. Азабачьего (вскрыто по 15—17 экз.)

Паразит / Parasite	Predators of Lake Azabach'e — Хищники оз. Азабачье						Predators of the Azabach'ye River — Хищники р. Азабачья						Benthophages of Lake Azabach'e — Бентофаги оз. Азабачье						Benthophages in Azabach'ye River — Бентофаги р. Азабачья	
	июль / July		август / Aug.		сентябрь / Sept.		июнь / June		июль / July		август—сентябрь / Aug.-Sep.		июль / July		август / August		сентябрь / Sept.			
	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.
	degree of infestation								degree of infestation										degree of infest.	
Myxidium salvelini	0		13.4		13.4		43.8		20.1		13.4		0		0		13.4		0	
Zschokkella orientalis	0		6.7		0		0		13.4		13.4		0		0		6.7		0	
Myxobolus neurobius	100		60.3		87.1		94.5		46.9		67		46.9		80.4		80.4		23.6	
Henneguya zschokkei	0		6.7		13.4		0		6.7		6.7		0		6.7		0		11.8	
Trichophrya piscium	0		6.7		13.4		0		13.4		0		6.7		0		0		5.9	
Tetraonchus alascensis	0		20.1	1	6.7	1	0		6.7	1	6.7	2	0		0		0		0	
Gyrodactylus birmani	0		6.7	1	0		0		0		0		0		6.7	6	0		0	
Eubothrium salvelini	100	75.2	80.4	30	100	139	100	73	87.1	35.6	100	46.6	0		0		0		0	
Cyathocephalus truncatus	0		0		0		0		6.7	8	0		60.3	2.6	20.1	6.3	40.2	6.8	41.3	3
Diphyllobothrium sp. larva	100	22	60.3	23.7	100	20	100	20	87.1	13.9	73.7	8	0		0		0		0	
Proteocephalus exiguus	0		13.4	1	0		0		0		13.4	1	6.7	2	6.7	1	20.1	1	0	
Crepidostomum farionis	64.8	68	40.2	66.5	60.3	18	94.5	17	53.6	14.4	73.7	21	13.4	1.5	80.4	23.3	67	119	5.9	17
Phyllodistomum conostomum	5.9	5	20.1	9	40.2	17	56.7	12	46.9	34.3	67	5.9	20.1	242	53.6	52.5	80.4	255	76.7	43.9
Diplostomum sp.	—		26.8	6.3	67	3.2	37.8	3.7	13.4	1	53.6	4.3	13.4	17	33.5	1.8	93.8	38.5	17.7	19.3
Contracaecum sp.	5.9	1	20.1	9	6.7	2	0		6.7	40	20.1	1	20.1	.1	6.7	4	6.7	1	5.9	1
Cystidicola farionis	94.1	100	73.7	59.1	93.8	74	100	87	80.4	93	73.7	35	20.1	31	67	109.5	67	50	11.8	80
Cucullanus truttae	15.7	3	40.2	5.3	26.8	3	25.2	1.8	40.2	4	60.3	4.2	67	4.4	46.9	6.4	33.5	5.2	0	
Philonema oncorhynchi	0		33.5	4	0		44.1	2.5	40.2	4.2	40.2	4.2	0		0		0		0	
Neoechinorhynchus rutili	5.9	1	6.7	4	13.4	1	44.1	10	26.8	29	40.2	6.5	0		13.4	1.5	0		0	
Metechinorhynchus salmonis	70.6	12.4	33.5	49	87.1	20.4	94.5	8.6	73.7	15.3	80.4	16	40.2	102.3	33.5	54	46.9	116.7	70.8	22
Acanthobdella livanowi	0		0		6.7	1	0		0		0		0		0		0		0	
Anodonta yukonensis глохидии—glochidia	0		20.1	2	6.7	1	0		6.7	3	26.8	1.8	13.4	9.5	13.4	2	6.7	1	5.9	100
Salmincola edwardsii	0		6.7	6	13.4	1	18.8	1.7	13.4	8	6.7	6	0		0		26.8	3.8	5.9	2

We found the myxosporidians M. salvelini and Zschokkella orientalis Konovalow et Schulman, 1966 in small numbers in all char forms (Table 5 and 6); as it happened, however, in June and July we found mainly Plasmodia, while spores occurred as isolated individuals. Spores or Plasmodia with spores forming in them occurred more often in August. In September and October we found masses of spores. Thus here we observe that the spore formation of parasites is confined to the time of the greatest density of the fish during the spawning period, which ensures the infestation of the chars. At the same time, in the northwest European USSR spore formation by Z. nova Klocacewa, 1914, a parasite of the same genus, takes place in the spring during the period when the parasite's host fish spawn (Malakhova, 1963; Rumyantsev, 1966; S. Shul'man, 1966; R. Shul'man and Grozdilova, 1969).

The infestation of chars with M. neurobius probably takes place continuously during the year, which caused the high incidence of infestation of fish during all the months of our investigation (Tables 5 and 6).

Table 6

Таблица 6

Паразит Parasite	Июнь June		Июль July		Август August		Сентябрь—октябрь Sept.—Oct.	
	%	интенсивн.	%	интенсивн.	%	интенсивн.	%	интенсивн.
		degree of infestation						
Myxidium salvelini	0		0		0		26.8	
Zschokkella orientalis	6.7		0		0		0	
Leptotheca krogiusi	6.7		0		0		0	
Chloromyxum coregoni	6.7		0		0		6.7	
Myxobolus neurobius	26.8		0		46.9		46.9	
Myxobolus krokhini	0		0		0		0	
Henneguya zschokkei	6.7		0		0		0	
Trichodina nigra kamchatika	0		0		0		20.1	
Trichophrya piscium	53.6		13.4		6.7		13.4	
Cyathocephalus truncatus	0		0		6.7	2	0	
Proteocephalus exiguus	20.1	4	6.7	1	20.1	1	40.2	2.7
Crepidostomum farionis	6.7	1	0		13.4	35	13.4	2
Diplostomum sp.	6.7	1	0		6.7	1	40.2	7.2
Contracaecum sp.	0		0		6.7	1	0	
Cystidicola farionis	26.8	10.8	26.8	10	80.4	24.5	13.4	11
Cucullanus truttae	80.4	3.5	80.4	3.5	87.1	4.2	67	17.3
Philonema oncorhynchi	0		0		0		13.4	2.5
Metechinorhynchus salmonis	0		0		6.7	7	0	
Acanthobdella livanowi	0		0		0		6.7	1
Anodonta yukonensis глохидии	0		0		0		0	
Salmincola edwardsii glochidia	6.7	1	0		0		6.7	1

We found Gyrodactylus birmani Konovalow, 1967 in lake chars only in August (Table 5).

The incidence of infestation of predators by the cestodes Diphyllobothrium sp. and E. salvelini remained high during all the months of our investigation. The life cycle of Diphyllobothrium sp. can last over a year owing to the prolonged existence of encysted plerocercoids in the fish. During the whole period of our investigation E. salvelini was represented by individuals of different ages. The high percentage of infestation of predators was sustained by new infestations of the chars from feeding on juvenile sockeye, smelt and stickleback.

The trematodes Crepidostomum farionis and Phylodistomum conostomum infested chars during all the months of our investigation, and in July and August we observed that infestation abated (Table 5). These parasites evidently have a one-year developmental cycle like those described by R.P. Malakhova (1963). The fish became infested in July /244
and August. At this time small, sexually immature parasites occurred in the chars. We observed the heaviest infestation at the end of the summer and in the autumn and found both mature and sexually immature parasites in chars in September. The worms mature during the winter, and in the following summer they produce eggs and leave the fish, which explains the drop in their abundance.

Metacercariae of Diplostomum sp. can parasitize fish for a long time. An interesting point to note is the considerable increase in the infestation of chars in August and September, which is due to new infestation.

Nematodes of Cystidicola farionis were represented during the period of our investigation by both sexually mature and sexually immature parasites. The high percentage of the infestation was probably maintained by new infestations, with the simultaneous maturation of the parasites of the preceding infestation.

C. truttae was also represented by material of different ages. Fresh infestation of the chars took place in the summer, mainly in July and August. In September we found mainly mature parasites with eggs or with a well-developed reproductive system, but still without eggs. The parasites finally matured during the winter and produced eggs in the spring. The larvae hatched in the late spring and at the beginning of summer. They became invasive in the autumn, the winter or the following spring. Thus this parasite has a one-year developmental cycle (Gibson, 1972).

We found Philonema oncorhynchi in large numbers only among predaceous chars in the Azabach'e River, and the percentage of infestation remained high during all the months of our investigation (Table 5). We recorded the young parasites of a new infestation in chars in August and September. The release of larvae by the female was confined to the time when the fish spawned (Pennel et al, 1973).

Nematodes of Contracaecum sp. occurred in small numbers in all forms of chars (Tables 5 and 6). We found larvae along with mature parasites during the entire period of our investigation.

Acanthocephalans of M. salmonis infest predators, benthophages and diadromous chars. This parasite has a one-year developmental cycle. Sexually mature parasites occur mainly in spring and summer. During the summer months a new infestation of the fish occurs, and the sexually mature parasites withdraw. During the autumn and the winter all the young parasites increase in size and mature. They produce eggs in the following spring and summer.

The acanthocephalan Neoechinorhynchus rutili (Müller, 1780) infests more or less substantially only the predators in the Azabach'e River (Table 5). This parasite is found in other chars only as solitary individiuals. The infestation of predators by N. rutili declines in the summer due to the withdrawal of the sexually mature parasites. A new infestation takes place at the end of the summer and in the autumn. We found the leach Acanthobdella livanowi (Epstein, 1966) in a lake predator only in September; this parasite did not occur in summer. We found glochidia of [the freshwater mussel] Anodonta among char chiefly in July and August, the heaviest infestation occurring in July. Glochidia occurred only as solitary specimens in autumn (September).

Discussions of Results

Our study of the parasitic fauna of different char forms in terms of age has shown that they [the char forms] do not differ significantly in the early stages of juvenile development. The fingerlings and yearlings 6 to 10 cm long of all char forms have a similar ecology and food habits, and hence a similar parasitic fauna develops on them. We find different protozoans (Ch. coregoni, M. salvelini, M. neurobius) in the juveniles of this age group. Chars in small rivers become infested with C. truttae, and when they feed on plankton, they are infested with P. exiguus.

In their second year of life (length 11-15 cm) the juveniles' food habits alter substantially: the predators change over to feeding on juvenile sockeye salmon, smelt and stickleback, while the benthophages feed on mollusks and amphipods (Kokhmenko, 1970). Brook chars continue to feed on larvae and adult insects, and diadromous chars use both invertebrates and occasionally fish as food. The parasitic /245
fauna of different char forms changes as the latter's food habits alter. Predators are infested with the cestodes Diphyllobothrium sp. and E. salvelini, and benthophages, with Ph. conostomum, C. truncatus and M. salmonis. The different food habits of predaceous chars and benthophages also affect the varying degree to which these fish are infested with parasites common to both [forms]. This is illustrated by C. truncatus, whose intermediate hosts are amphipods (Tables 2 and 3). Benthophages are much more heavily infested with this parasite since they feed on amphipods. The incidence of infestation of predators is low; they accumulate parasites by eating stickleback. The species composition of parasites in brook chars remains steady, and only their

infestation with P. exiguus and C. truttae is increasing. Diadromous chars, owing to their diverse food habits, are infested with parasites that are characteristic of both benthophages and predators. Common parasites of the juveniles of all char forms in this age group include certain species of protozoans and the nematode C. truttae (Tables 2 and 3).

Among the two- and three-year-olds of different char forms (length 16-20 cm) differences in food habits remain steady, and we see an increase only in the amount of food consumed and the sizes and age of the prey (Kokhmeno, 1972). The differences in the degree of the infestation of chars by parasites characteristic of them intensify correspondingly. We observe an increase in the infestation of predaceous chars by the cestodes Diphyllobothrium sp. and E. salvelini; of benthophages by trematodes, acanthocephalans and glochidia; and of brook chars by the nematode C. truttae.

We can distinguish parasites whose rate of infestation intensifies with the age of the fish. These include M. neurobius, Diphyllobothrium sp., E. salvelini, Ph. conostomum, Diplostomum sp. and Cystidicola farionis. On the other hand, the infestation of chars by C. truttae declines with age. Only brook chars are an exception in this regard: they become more infested with C. truttae as they get older.

Our study of the biology of certain char parasites has shown that sexual maturation and infestation with a new generation of parasites having a complex developmental cycle, occurs in July and August. Thus development is later than in the European USSR.

The life cycles of some myxosporidians are adapted to the biological peculiarities of their host fish. Thus in M. salvelini

and Z. orientalis spore formation and new infestation take place in autumn, in September and October, during the period when the chars spawn. At the same time, in the northwest European USSR we observe spore formation in Z. nova in the spring, while their fish hosts spawn.

We may note the following special features of the parasitic fauna of the char forms that we have investigated as a whole:

a) limited infestation with protozoans, except for T. piscium and M. neurobius;

b) a low degree of infestation, and poor species composition, among monogenean trematodes (2 species). The high degree and intensity of the infestation of chars by cestodes, trematodes and acanthocephalans are due to the abundant invertebrate fauna - Cyclops, mollusks and amphipods - serving as intermediate hosts of helminths.

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DYNAMICS OF THE PARASITE FAUNA OF DIFFERENT FORMS OF SALVELINUS ALPINUS L. FROM THE BASIN OF THE LAKE AZABACHJE

T. E. Butorina

SUMMARY

The paper deals with age changes in the parasite fauna of different intraspecific forms of chars. It is shown that this year brood and yearlings of predatory, benthofagous, stream and anadromous chars up to 10 cm in length have a similar parasite fauna. During the second year of life the chars come to different feeding; correspondingly changes their parasite fauna which differs considerably in the above forms of chars. Two groups of parasites are distinguished the infection with which increases and decreases with the age of fishes. Observations were carried out on the life cycles, developmental and maturation periods of some parasites of chars. Biological peculiarities of some mixosporidia are studied. A shift in the developmental periods of helminths is noted as compared to those from the European part of the USSR.